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[Claim(s)]

[Claim 1] General formula: MgbalXaLnb (however, [b / at least at least a kind of element chosen from Zn, nickel, and Cu X, a kind of element with which Ln is chosen from Y, La, Ce, and Mm {misch metal}, a, and b are atomic percents, and]) The high intensity magnesium machine alloy with which the above-mentioned fine crystalline organization is characterized by the intermetallic compound of only a Mg-Ln system distributing uniformly at Mg matrix of H.C.P. in the magnesium machine alloy which has 1<=a<=10 and the fine crystalline organization shown by 1<=b<=20.

[Claim 2] The high intensity magnesium machine alloy according to claim 1 whose intermetallic compounds of a Mg-Ln system are Mg17Ce2, Mg12Ce1, Mg12La1, Mg17La2, Mg17Y3, and Mg5Y2 at least.

[Claim 3] H. High intensity magnesium machine alloy according to claim 1 with which the intermetallic compound of a Mg-Ln system is distributed over Mg matrix of C.P. 10 to 50% by the volume rate.

[Claim 4] General formula: MgbalXaLnb (however, [b / at least at least a kind of element chosen from Zn, nickel, and Cu X, a kind of element with which Ln is chosen from Y, La, Ce, and Mm, a, and b are atomic percents, and]) In the magnesium machine alloy which has 1<=a<=10 and the fine crystalline organization shown by 1<=b<=20 High intensity magnesium machine alloy collection solidification material which the above-mentioned fine crystalline organization does the collection solidification of the material which the intermetallic compound of only a Mg-Ln system is distributing uniformly to Mg matrix of H, C, and P, and is characterized by things.

[Claim 5] High intensity magnesium machine alloy collection solidification material according to claim 4 whose size of the grain size of Mg matrix and the average grains of an intermetallic compound is 5 micrometers or less.

[Claim 6] High intensity magnesium machine alloy collection solidification material according to claim 4 or 5 whose intermetallic compounds of a Mg-Ln system are Mg17Ce2, Mg12Ce1, Mg12La1, Mg17La2, Mg17Y3, and Mg5Y2 at least.

[Claim 7] H. High intensity magnesium machine alloy collection solidification material according to claim 4

from which the intermetallic compound of a Mg-Ln system is distributed over Mg matrix of C.P. 10 to 50% by the volume rate.

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the magnesium machine alloy collection solidification material which carries out the collection solidification of the material obtained by the magnesium machine alloy and liquid quenching method which have ductility with the high intensity obtained by a liquid quenching method.
[0002]
[Description of the Prior Art] Into the conventional magnesium machine alloy, a Mg-aluminum system, a Mg-aluminum-Zn system, The alloy of component systems, such as a Mg-Th-Zn system, a Mg-Th-Zn-Zr system, a Mg-Zn-Zr system, and a Mg-Zn-Zr-RE (rare earth elements) system, is known, and the use wide range as a lightweight structural element is presented according to the material property. Moreover, the alloy given in JP,H3-47941,A is known as a material obtained by a liquid quenching method.
[0003]
[Problem to be solved by the invention] [however, the conventional magnesium machine alloy of the various above-mentioned systems] Generally hardness and hardness of the present condition are low, and, as for the alloy shown in above-mentioned JP,H3-47941,A, it has left the room for an improvement as hardness and a material as which high toughness is required although it pulls and being excelled in hardness. [an alloy / when the alloy furthermore shown in JP,H3-47941,A obtains this as powder or a thin band with a melt quenching method, and processing these variously as a raw material and obtaining a final product, it is excellent also in hardness and hardness about the case where it is considered as a product only by primary operation, but] When forming solidification material by using this powder or a flake as a raw material and processing this further (i.e., when carrying out fabricating), in the point of the maintenance of characteristics which was excellent in the material after the workability and processing, it has left the room for an improvement.
[0004] [then, the magnesium machine alloy useful as a material with which this invention has high hardness and high intensity in view of the above, and high toughness is demanded] Moreover, it aims at offering the aluminium machine alloy collection solidification material which consists of a specific presentation which can maintain the outstanding characteristics which face performing fabricating (extrusion, forging, cutting, etc.), and can perform the processing easily, and the raw material has after processing.
[0005]
[Means for solving problem] The 1st invention of this invention is general formula:MgbalXaLnb (however, [b / at least at least a kind of element chosen from Zn, nickel, and Cu X a kind of element with which Ln is chosen from Y, La, Ce, and Mm, a, and b are atomic percents, and]). In the magnesium machine alloy which has 1<=a<=10 and the fine crystalline organization shown by 1<=b<=20, the above-mentioned fine crystalline organization is the high intensity magnesium machine alloy characterized by the intermetallic compound of only a Mg-Ln system distributing uniformly to Mg matrix of H.C.P.

[0006] The 2nd invention of this invention is general formula:MgbalXaLnb (however, [b / at least at least a kind of element chosen from Zn, nickel, and Cu X a kind of element with which Ln is chosen from Y, La, Ce, and Mm, a, and b are atomic percents and]). In the magnesium machine alloy which has 1<=a<=10 and the fine crystalline organization shown by 1<=b<=20 The above-mentioned fine crystalline organization does the collection solidification of the material which the intermetallic compound of only a Mg-Ln system is distributing uniformly to Mg matrix of H.C.P., and is the high intensity magnesium machine alloy collection solidification material characterized by things.

[0007] Moreover, specifically, Mg17Ce2, Mg12Ce1, Mg12La1, Mg17La2, Mg17Y3, Mg5Y2, etc. can be illustrated as an intermetallic compound of a Mg-Ln system.

[0008] Since the ductility in a room temperature is inferior when it is desirable to be distributed 10 to 50% by the volume rate in Mg matrix of H.C.P. as for these intermetallic compounds, this does not have [less than 10% of case] enough room temperature hardness and 50% is exceeded, It is for the problem that obtained material cannot fully be processed to arise. Furthermore, as for these intermetallic compounds, it is desirable in Mg matrix of H.C.P. that it is 15 to 40% in a volume rate.

[0009] As an intermetallic compound uniformly distributed by Mg matrix in the above A Mg-Ln system intermetallic compound is useful in respect of the improvement in a mechanical property, and toughness, and since the obtained material becomes weak when a Mg-X system intermetallic compound deposits, an alloy organization needs to deposit only the intermetallic compound of a Mg-Ln system in Mg matrix.

[0010] a was limited and b was limited to 1 - 20at% of the range 1 - 10at% in the magnesium machine alloy of above-mentioned this invention, respectively in order to form the supersaturated solid solution beyond a solid-solution limit, and in order to obtain the alloy which consists of a fine crystalline with the industrial quenching means using a melt quenching method etc.

[0011] By [still more important] making it the above-mentioned range as a Reason, it is for Mg of H.C.P. to deposit, for the still more detailed intermetallic compound which Mg and Ln generate at least to deposit to Mg of this detailed H.C.P., and for this to distribute uniformly minutely. By distributing uniformly minutely the intermetallic compound which becomes Mg matrix of above-mentioned H.C.P. from Mg and Ln at least, Mg matrix can be strengthened and the hardness of an alloy can be raised by leaps and bounds. In addition, although a phase can be decomposed by obtaining that in which Above a contains an amorphous phase at least in the quantity in which 10at% or/and b exceed 20at%, and heating this at a specific temperature When the thing of this condition is produced by thermal decomposition, there is a tendency for the intermetallic compound which an intermetallic compound deposits more preferentially [simultaneously with Mg of H.C.P.] than this, and consists of Mg and X to deposit easily, and toughness falls. Moreover, [in the case of the alloy with which the quantity of b exceeds 20at%, or/and the quantity of Above a exceeds 10at%, the above-mentioned thing and a similar thing are obtained also by making a cooling rate small, but] Since only what compound grains distributed is obtained while not becoming a solid solution phase in the state of cooling, only the low thing of toughness is obtained.

[0012] An X element is a kind of element chosen from Zn, nickel, and Cu at least, solid solution strengthening of these elements is carried out to Mg, and they do so the effect of improving a mechanical property.

[0013] Ln element is at least a kind of element chosen from Y, La, Ce, and Mm, and [these elements] An intermetallic compound as stable as a magnesium element or metastable is formed, into a magnesium

matrix (alpha phase), it is made to distribute uniformly minutely, the hardness and hardness of an alloy are raised remarkably, big and rough-ization of a hot fine crystalline is controlled, and a heat-resisting property is given. Especially with the alloy of this invention, the intermetallic compound of a Mg-Ln system which can improve a mechanical property can be formed. Moreover, the outstanding ductility can be given from specifying the volume rate of the intermetallic compound of a Mg-Ln system with 10 to 50%.

[0014] The magnesium machine alloy of this invention can be obtained by carrying out the rapid solidification of the molten metal of an alloy which has the above-mentioned presentation with a melt quenching method. This melt quenching method means the method of making the fused alloy cooling quickly, for example, is effective, and an about [102-108K/sec] cooling rate is obtained by these methods. [of a single-roll process, a twin-roll process, especially an in-rotating liquid spinning process, etc.] In order to manufacture thin band material with this single-roll process, a twin-roll process, etc., a molten metal is spouted on steel rolls, 30-300mm in diameter, for example, copper, which is rotating through a nozzle hole at the rate of [fixed] the range of about 300-10000rpm or. Thereby, width can obtain easily various about 5-500-micrometer-thick thin band material at about 1-300mm. Moreover, in order to manufacture filament material with an in-rotating liquid spinning process, a molten metal is blown off through a nozzle hole in a solution cooling medium layer with a depth of about 1-10cm held by centrifugal force in the drum which rotates at about 50-500rpm with argon gas back pressure, and filament material can be obtained easily. As for the angle of the jet molten metal from the nozzle in this case, and a refrigerant side to make, it is [the relative velocity ratio of a jet molten metal and a solution refrigerant side] desirable that it is about 0.7-0.9 about 60 to 90 degrees.

[0015] In addition, quenching powder can be obtained by not being based on the above-mentioned method but grinding a thin film for the spraying rolling method, above-mentioned thin bands, etc., such as a high pressure gas atomizing process, by the sputtering method again.

[0016] The alloy of this invention can be obtained by the above-mentioned single-roll process, a twin-roll process, an in-rotating liquid spinning process, the sputtering method, the spraying rolling method, the mechanical alloying process, the mechanical gliding method, etc. Moreover, the size of an average crystal grain diameter and the average grains of an intermetallic compound and the volume rate of an intermetallic compound are controllable by choosing suitable manufacture conditions if needed.

[0017] Furthermore, although an amorphous organization can be obtained depending on a presentation, if this amorphous organization heats, it will be decomposed into a crystalline substance above a specific temperature. this invention alloy can be obtained also by thermal decomposition of this amorphous organization, and an above-mentioned grain size and an above-mentioned volume rate can be controlled by choosing heating conditions suitably in that case.

[0018] The production method of the magnesium machine alloy collection solidification material of this invention is a method characterized by fusing and carrying out the rapid solidification of the material of the presentation shown by the above-mentioned general formula again, collecting the obtained powder or flake and carrying out pressing solidification by the usual plastic processing means. In this case, the powder or flake used as raw material requires that the size of the average grains of an intermetallic compound should be fine crystallines or these mixed phases of 5 micrometers or less at the average crystal grain diameter of 5 micrometers or less as shown in amorphousness, a supersaturated solid solution, or the above. In the case of amorphous material, it can be made into the fine crystalline of the above-mentioned conditions, or a mixed phase by heating at 50 degrees C - 400 degrees C at the time of collection.

[0019] The above-mentioned usual plastic processing technology is the thing of a wide sense, and pressing and powder metallurgy technology are also included.

[0020] In the magnesium machine alloy collection solidification material of this invention, Mg matrix average crystal grain diameter is limited to 5 micrometers or less because hardness falls rapidly and the thing of high intensity is no longer obtained, and when exceeding 5 micrometers, it is because 5 micrometers or less are required in order to obtain the solidification material of high intensity. Moreover, when the size of average grains exceeded 5 micrometers, the size of the average grains of an intermetallic compound was limited to 5 micrometers or less because it stopped working as a strengthening element while a particulate material becomes large too much and strong maintenance becomes impossible. Furthermore, as for the size of the average grains of an intermetallic compound, 1 micrometer or less is desirable.

[0021] [the material] although the magnesium machine alloy collection solidification material of this invention can control an average crystal grain diameter, the mean particle diameter of an intermetallic compound, and the distributed state of an intermetallic compound by choosing suitable manufacture conditions When thinking hardness as important, an average crystal grain diameter and the mean particle diameter of an intermetallic compound are controlled small, and when thinking ductility as important, the thing appropriate for the various purposes can be obtained by controlling the quantity of the intermetallic compound which deposits in Mg matrix.

[0022]

[Working example] Based on a work example, this invention is explained concretely hereafter.

[0023] The magnesium machine after alloy powder which has the component composition shown in Table 1 with work-example 1 spraying roll equipment is produced. After filling up a metal capsule with the produced magnesium machine after alloy powder, it extrudes, while a vacuum hot press performs degasifying at the temperature of 200-450 degrees C, and the billet of business is produced. The extruder performed this billet and it extruded at the temperature of 200-550 degrees C (preferably 250-400 degrees C).

[0024] 18 sorts of solidification material (extruded material) which has the presentation (atomic %) shown in the left column of Table 1 according to the above-mentioned manufacture conditions was obtained.

[0025] About each sample (extruded material; solidification material) obtained by the above-mentioned manufacture conditions, the mechanical property (tensile strength, hardness, elongation) shown in the Table 1 right column was investigated. Hardness (Hv) is the measured value (DPN) by the minute Vickers hardness meter of 25g load. In addition, all over Table 1, the main intermetallic compound phase which deposited, and its volume rate specified the result of TEM observation.

[0026]

[Table 1]

	組成 at%			化合物相	化合物の体積率 (%)	引張強度 σ_f (Mpa)	硬度 Hv (DPN)	伸び ε_f (%)
	Mg	X元素	Ln元素					
本発明例1	残	Cu=5	Mm=1	$Mg_{17}Ce_2$, $Mg_{12}Ce_1$ $Mg_{12}La_1$, $Mg_{17}La_2$	12	412	85	7.5
〃 2	〃	Cu=1	Mm=5	〃	22	578	112	5.6
〃 3	〃	Cu=10	Mm=5	〃	25	530	118	4.3
〃 4	〃	Cu=2	Mm=10	〃	30	545	113	5.3
〃 5	〃	Cu=10	Mm=10	〃	33	530	120	4.0
〃 6	〃	Cu=2	Mm=20	〃	46	521	127	4.8
〃 7	〃	Zn=5	Mm=1	〃	11	403	79	7.9
〃 8	〃	Zn=1	Mm=5	〃	17	534	103	5.8
〃 9	〃	Zn=10	Mm=5	〃	21	548	112	5.0
〃 10	〃	Zn=2	Mm=10	〃	29	555	113	6.1
〃 11	〃	Zn=10	Mm=10	〃	40	545	124	4.8
〃 12	〃	Zn=2	Mm=20	〃	48	497	131	4.2
〃 13	〃	Ni=5	Mm=1	〃	10	448	95	7.8
〃 14	〃	Ni=1	Mm=5	〃	15	598	118	6.7
〃 15	〃	Ni=10	Mm=5	〃	15	581	121	4.8
〃 16	〃	Ni=2	Mm=10	〃	32	557	118	5.3
〃 17	〃	Ni=5	Mm=10	〃	35	532	123	4.7
〃 18	〃	Ni=1	Mm=20	〃	45	485	134	4.1

[0027] As for 79 or more and tensile strength, as for any sample, hardness Hv (DPN) shows more than 4.1 (%) and outstanding characteristics more than 403 (MPa), as for elongation as shown in Table 1.

[0028] Like the work-example 2 above-mentioned work example 1, the extruded material (solidification material) of MgbalZn2CeX was produced, and it investigated about the relation between the volume rate of a MgCe system intermetallic compound (Mg17Ce2, Mg12Ce1), tensile strength, and elongation.

[0029] This result is shown in drawing 1 .

[0030] In addition, the volume rate of the above-mentioned intermetallic compound measured using the technique of the image analysis according the obtained solidification material to TEM. Moreover, the intermetallic compounds which deposited by the above-mentioned sample were mainly Mg17Ce2, Mg12Ce1, etc.

[0031] It turns out that it will decrease if an intermetallic compound increases rapidly to 15% by a volume rate and tensile strength exceeds 40% from drawing 1 (rapidly), and it turns out that elongation decreases to **** with the increase in an intermetallic compound, and it falls from 2% of elongation required of 55% in the

case of general processing at worst. In addition, the alloy composition of 30% of the volume rate was Mg88Zn2Ce10.

[0032] Like the work-example 3 above-mentioned work example 1, the extruded material (solidification material) of MgbalCu5LaX was produced, and it investigated about the relation between the volume rate of (Mg17La2, Mg12La1) of a MgLa system intermetallic compound, tensile strength, and elongation.

[0033] This result is shown in drawing 2 .

[0034] An intermetallic compound increases tensile strength from drawing 2 rapidly to 15% by a volume rate. When 40% is exceeded, it turns out that it decreases rapidly, and it turns out that elongation decreases to **** with the increase in an intermetallic compound, and it falls from 2% of elongation required in the case of general processing at worst at 55% (in addition, the alloy composition of 35% of the volume rate was Mg85Cu5La10).

[0035] Like the work-example 4 above-mentioned work example 1, the extruded material (solidification material) of MgbalNi4YX was produced, and it investigated about the relation between the volume rate of a MgY system intermetallic compound (Mg17Y3, Mg5Y2), tensile strength, and elongation.

[0036] This result is shown in drawing 3 .

[0037] When an intermetallic compound increases rapidly to about 15% by a volume rate and tensile strength exceeds about 40% from drawing 3 , it turns out that it decreases rapidly, and when elongation decreases to **** with the increase in an intermetallic compound and about 40% is exceeded, it turns out that it is falling rapidly. Moreover, it turns out that 2% of elongation required in the case of general processing at worst is acquired by 55% or less of the volume rate. In addition, the alloy composition of 33% of the volume rate was Mg86nickel4Y10.

[0038] Furthermore, as a result of carrying out TEM observation of the sample of work examples 1-4, the above-mentioned sample is the matrix of the supersaturated solid solution of magnesium with an average crystal grain diameter of 5 micrometers or less or magnesium. And the grains which consist of various intermetallic compounds which a matrix element and Ln element generate were uniformly distributed in said matrix, and the size of the average grains of this intermetallic compound was 5 micrometers or less.

[0039]

[Effect of the Invention] The magnesium machine alloy of this invention is useful as mentioned above as a material as which it has high hardness and high intensity, and high toughness is required.

[0040] Moreover, the magnesium machine alloy collection solidification material of this invention can maintain the outstanding characteristics which the raw material which faced performing fabricating (extruding forging, cutting, etc.), and could perform the processing easily, and was manufactured by the liquid quenching method after processing has.

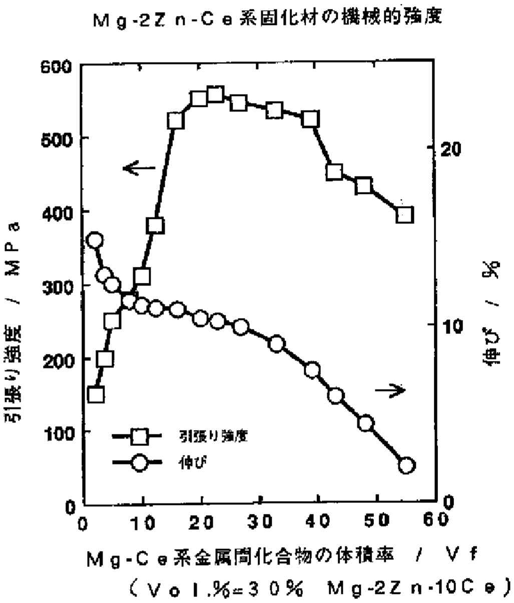
[Brief Description of the Drawings]

[Drawing 1] It is the graph in which the test result of a work example 2 is shown.

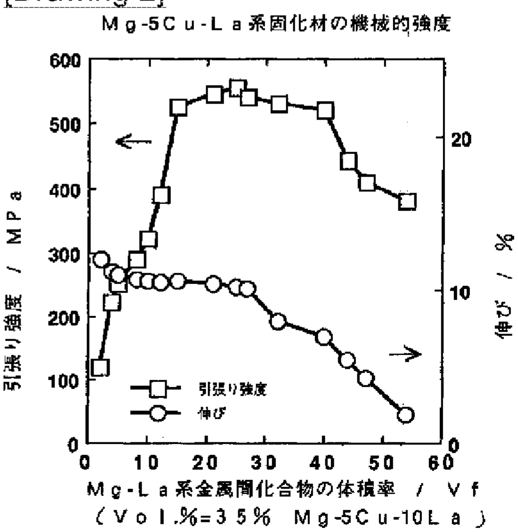
[Drawing 2] It is the graph in which the test result of a work example 3 is shown.

[Drawing 3] It is the graph in which the test result of a work example 4 is shown.

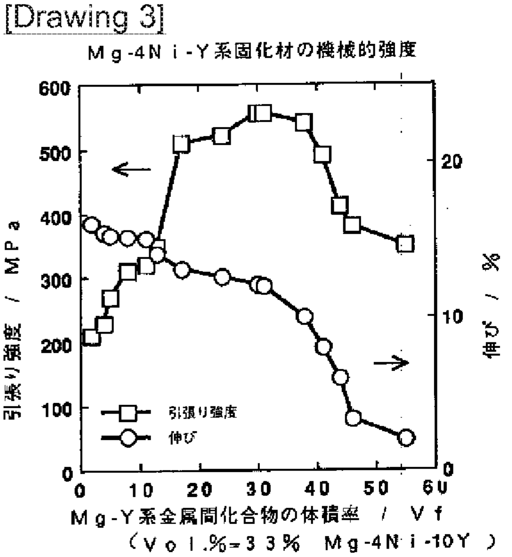
[Drawing 1]



[Drawing 2]



[Drawing 3]



[Translation done.]